THE FOSSIL COLLECTOR

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Sign at Limestone Road, Yea fossil site, see "The *Baragwanathia* Story: An Upadate", page 9.

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Taxonomic Disclaimer

This publication is not deemed to be valid for taxonomic purposes [see article 8b in the *International Code of Zoological Nomenclature* 3rd edition 1985. Eds W. D. Ride et al].

CONTENTS

EDITORIAL NOTES

I hope all readers and their families had a safe, happy Christmas and New Year. I have had an absolutely wonderful time since September last year, some of the details of which are below.

It all started with a return to Winton for the first two weeks of September to participate in the second dinosaur dig of the year and the opening of a new dig site. This time it didn't rain and there were dinosaur bones a plenty for people to work on, even a very large but incomplete metacarpal for me to dig out. This new dig site is a little different from the previous in that there is a sandstone lens overlying the usual shale layer and it was in, around and through this sandstone lens that most of the bones were to be found, with some of the bones also running through the sandstone into the shale. The sandstone wasn't totally removed (we ran out of time), with the remainder disappearing at a slight downward angle into the overlying black soil. At present it isn't known just how much further the sandstone will continue but one can only hope it will continue for some distance and contain the same abundance of dinosaur remains. After the metacarpal experience, my highlight was adding considerably to the fossil insects recovered from the Winton Formation. Before this dig there were only six insects known from the Winton Fmn. this has now grown to about twenty-six. All the wings were found in the shale underlying the sandstone lens and together with the abundant but fragmentary plant remains found with the wings, shows me that this area must have been a rich and diverse area for life during the Cretaceous. It was also very exciting to wonder around the overburden piles from previous digs, examining and cracking open ironstone nodules that had weathered out of the shale piles. Some of these nodules contained quite beautiful *Araucaria*, and other conifer, cones as well as the odd Angiosperm leaf. All of us associated with the dinosaur digs are very excited about what this years dig will provide with the further uncovering of the sandstone lens and the possibility of a whole lot more bone material, not to mention insects.

Then to cap the September trip, fellow FCAA member Mark Saul and I travelled to Victoria during the first two weeks of October to meet a few people I have long wanted to meet and to take in some of Victoria's palaeontological and scenic wonders. To say we had a wonderful time is a fantastic understatement as it was one of the best experiences of my life and a return trip to Victoria at some time in the future is something I am already hoping to achieve (2007 is looking good at the moment). The fossil collecting was great, both in the field and shopping (yes I spent a bit of money on fossils at a couple of shops), the specimens of *Clypeaster* and *Waurnia* (echinoids) I collected and took home are beautiful. I was also fortunate to return home with some sharks teeth and a very attractive *Baragwanathia* specimen. We were also able to pay a visit to Museum Victoria to meet some of the palaeontologists who work there and to also see the palaeontological collection. I was impressed and somewhat

envious of the exquisite Ordovician/Silurian fossils Victoria has, something Queensland is a little lacking in, but we can't have everything and I am sure there are some things Queensland has that Victoria hasn't! I must also congratulate you Victorians on some of the best scenic drives around. The drive from Warburton toward Matlock along the Yarra Track is positively breathtaking and fossils can be collected at the same time, wow. Another drive I will not soon forget was the one from Paynsville to Wangaratta via the Great Alpine Road, totally awe inspiring and truly the **ICE**ing on the cake. This drive also fulfilled a couple of things I wasn't counting on, Mark had never seen snow and I had never seen snow falling, well I'm happy to say we can now mark those off in our books of life. *The Fossil Collector* probably isn't the place to thank/acknowledge people for personal experiences but in this case I feel justified. Mark and I would like to especially thank Frank Holmes for being the best host and tour guide one could hope for, special thanks also go to Chris Ah Yee, Janice Krause, George Rawlings, Mary & Varo Dharmarajah and to those people who spent time with us in the field (and whose names I have forgotten), you have all made our trip to Victoria a special experience.

What is in store for 2006 I hear some say. June will see two very special North American friends visit which will include at least a week in western Queensland collecting fossils and looking at the stars (astronomy). December will see me travel to the U.S.A. for three weeks to hopefully experience a white Christmas and of course to collect some fossils. Now that I have the required stereomicroscopes, camera etc. we will be going up a gear with our Triassic insect project with the hope of having at least one paper published by the end of this year. There is also a new Tertiary (Oligocene?) locality which has the best plants for their age I have ever seen in Queensland, some of the leaves still have a green colouration when wet and as the rock dries out they change to brown. Ayla and Nakita (my two oldest daughters) have also taken a keen interest in palaeontology so when the weather cools a little I will be spending as much time as possible with them in the field collecting and also introducing my youngest daughter Ebonee to the joys of palaeontology. All in all another full year.

Readers will also notice that my address and telephone number have changed, yes I am now the owner of a mortgage again but it is one I am very happy to have. By the time this issue of *The Fossil Collector* is released I will also have a new email address as with the new house I have also decided to advance from the dark ages (dialup) and come into the light with broadband, ten times quicker for not much extra cost. I have included my new email address on page 2 of this issue.

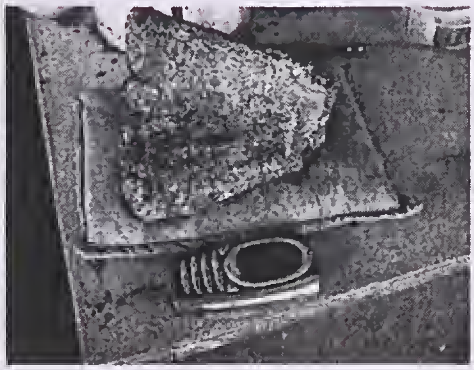
Pages five and six of this issue have some pictures of my experiences from the last third of 2005.

SEPTEMBER TRIP, WINTON QUEENSLAND.

Blacksoil overburden being removed prior to start of dig. Plastic at left is where the sandstone lens is.

The sandstone has been uncovered and removal of fossil bone started. The sandstone lens runs from left to right and dips downward to the right.

Final cleanup with the sandstone/ bone removed. The starpicket (left centre) is where the sandstone continues.

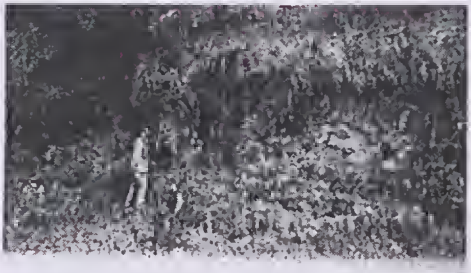


The incomplete metacarpal I was able to recover. Has been partially prepared. Mobile phone is 10.5 cms long.

OCTOBER TRIP, VICTORIA.

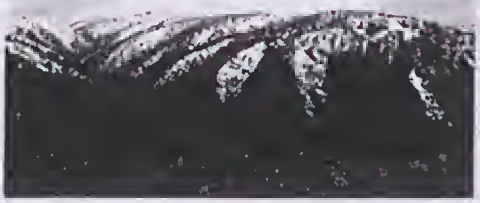
Bullengarook slate quarry, graptolite locality.

I just love Melbourne trams.



Graptolite locality on the Yarra Track.

Limestone quarry in which specimens of the echinoid *Clypeaster* can be found.



Snow, something us Queenslanders don't see a lot of.

Limestone quarry where the echinoid *Waurnia* can be found along with sharks teeth..

BOOKS AND BOOK REVIEWS

FOSSIL PLANTS by Paul Kendrick and Paul Davis. The Natural History Museum, London, 2004. Softcover, 216 pp. Available in Australia from CSIRO Publishing, P.O. Box 1139, Collingwood, Victoria 3066. ISBN 0-643-09131-9, RRP AU$59.95.

> Although we included a publisher's note about this book in the September Bulletin, it now seems appropriate to give a full review in view of our lead article on *Baragwanathia.*

'Fossil Plants' is the third in the *Living Past Series* produced by the Natural History Museum, London. Like an earlier volume on Ammonites, it gives an informative overview of the subject without becoming too specialised. As it is obviously necessary to use a number of botanical terms, the book contains a detailed glossary, aided by a very comprehensive index.

Apart from a final Summation, the book is divided into eight chapters: 1, In the beginning; 2, The Devonian explosion and its consequences; 3, Forests; 4, Coal; 5, Measuring the past; 6, Plant life through the ages; 7, Plants and animals; and 8, Modern Earth – the rise of flowers. As you can see, each deals with a particular aspect of plant evolution rather than simply a geological time related sequence of events. The text is easy to read and understand, more like a novel than a text book, and is well illustrated with predominately black and white photographs and drawings.

The first chapter deals with the origin of oxygen-producing photosynthesis; the most visible sign of life in the Proterozoic, the stromatolites that were formed by mat-forming microbes; the appearance of green algae by the late Neoproterozoic; and "the most bizarre and important green algae, the ones that became fully terrestrial". We also learn that the first spores, microscopic airborne cells, appeared about 470 million years ago in the Middle Ordovician and that "microscopic scraps of tissue, some of which could represent the decayed and fragmented remains of plants first appear in the Late Ordovician (450 Mya)". The chapter concludes with a detailed account of the Early Devonian Rhynie Chert, one of the world's most famous fossil sites, in which seven land plants, at least six groups of terrestrial and freshwater arthropods, algae, fungi, a lichen and bacteria have been found.

The second chapter, as the heading implies, concerns the rapid development, expansion and change in early plant forms that took place over a period of 30-40 million years. From very simple forms about 0.5 m high, species evolved that attained tree-like proportions 20 m or more in height. These early plants were primarily horsetails and clubmosses, the latter, which includes *Baragwanathia* [referred to and illustrated on pages 33-34], being the earliest recognisable 'modern' plants in the fossil record.

Chapters 3 & 4 cover the more generally known aspects of Palaeozoic plant evolution, such as the development of vast forests following the evolution of root systems and "the cambium: a region of dividing cells around the circumference of stems and roots that enable plants to increase in girth". The vegetation and climatic conditions that produced the extensive coal measures found in the Carboniferous [The Age of Coal] are described in detail. These include the lycopsids (clubmosses), the most famous of which is *Lepidodendron*, the horsetails and their relatives, ferns, seed ferns, and the first conifers.

'Measuring the Past (Chapter 5) deals with the identification of fossil plants, tree rings, leaf margins (shape), and their relationship with extant species, to determine past climates based on the latter's tolerance to specific climatic conditions. The statement, "The fossilised remains of plants and animals provide some of the finest evidence for changes in climate through geological time", effectively summarises this chapter.

While the heading of Chapter 6, 'Plant Life through the ages', is self explanatory, the chapter contains information that most of us would be unfamiliar with. For instance, did you know that palaeobotanists use the terms Palaeophytic, Mesophytic and Cenophytic, to describe the three 'stages' of plant evolution? The former commencing with the Silurian and extending into the Early Triassic and the latter commencing in the Middle Cretaceous (evolution of flowering plants) rather than at the K/T boundary. The time of the two major mass extinctions in plant evolution, the Early Triassic and the Palaeocene is another important fact worth noting.

Chapter 7 deals with the very important relationship between plants and animals and the specific effects the evolution of animals has had on the plant kingdom and vice versa.

Finally, the last chapter brings us up to the present day with the history of flowering plants replacing the gymnosperms and ferns as the dominant group in most habitats,

I can think of no better recommendation to our readers than to say, "it has been a long time since I've been so engrossed in a non-fiction book that it replaced my normal post midnight bedtime reading material (almost invariably crime fiction) for several days". When you think about it, the subject matter of this book is after all basically a detective story, as indeed are most things associated with palaeontology or palaeobotany.

Reviewed by Frank Holmes

THE BARAGWANATHIA STORY: AN UPDATE

by Jack Douglas[1] and Frank Holmes[2]

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The following article is a substantially updated version of "The Baragwanathia Story", originally published in The Fossil Collector, Bulletin 25, May 1988.

The appearance in the ancient Palaeozoic rocks of south-eastern Australia of the land plant *Baragwanathia,* usually fossilized as impressions of woody stems bearing long narrow leaves spirally arranged, is an enigma and a palaeontological wonder. Almost all other plant fossils from older rocks in the region (see Table 2.) belong to more primitive groups, principally marine algae. No ancestral line linking these groups with *Baragwanathia* has been found.

Baragwanathia, classified in the phylum Lycophytina, has present day relations in Victoria which include the club moss *Lycopodium*, a small herbaceous plant often present in coastal and alpine heath land.

The typical specimen is 10-15 cm in length with narrow leaves 3 cm long and 0.5-1 mm wide, extending up to 2 cm on either side of the stem. Preservation and recovery of specimens is affected by many factors including the nature of the rock matrix, method of extraction, and accessibility.

There are several other plant remains associated with *Baragwanathia,* but none of such large size or with woody tissue. Hence the following discussion of the history of discovery and study of the Late Silurian - Early Devonian land flora of south-eastern Australia very much revolves around *Baragwanathia longifolia,* Lang & Cookson, 1935. Age determination is based principally on the co-fossilized graptolite fauna, extensive studies of which facilitate detailed correlation between much of the world's early Palaeozoic sedimentary rocks.

Revised identification and discovery of additional graptolite species has resulted in the geological age of many localities being redetermined and rendering the age of *Baragwanathia* a subject of controversy.

THE EARLY YEARS, 1874-1934

The first record of the plant that we now call *Baragwanathia* is in a Victorian Mines Department report by William Nicholas dated 1874 (published in 1895). Investigating reports of fossils in railway cuttings near Avenel, central Victoria, he found fragmentary plant remains and one larger stem portion which was identified by University of Melbourne Professor Fredrick McCoy as "lepidodendroid". This became part of the collection of the National Museum of

Victoria (now Museum Victoria) and can be viewed today over 130 years later. *Lepidodendron* species flourished during the great coal-forming Carboniferous Period of the later Palaeozoic, and represent a later evolutionary line in the phylum Lycophytina..

During the next 50 years mapping parties from the Geological Survey of Victoria collected fossil plants along with other Silurian and Devonian fossils, but no descriptions were published. However, in 1925, Adele Vincent commented on the relationship of the Silurian and Devonian floras of Victoria, noting "a lycopodaceous cone....somewhat like *Lepidodendron* in appearance".

The next reference to a plant which might be referable to *Baragwanathia* was made by Isabel Cookson (1926) when she identified specimens from Walhalla and Rhyll (the latter in a bore core), as *Arthrostigma gracile*, a northern hemisphere Early Devonian species.

Soon after this, Cookson began a post-graduate association with Professor Lang at Manchester University, together re-identifying the Rhyll specimen as Cf. *Thursophyton* (Lang & Cookson, 1927). In addition they also described a number of fossils specimens from the Jamieson district which they could not relate to any northern hemisphere pre-Carboniferous plant. Eight years later similar specimens were to be described as *Baragwanathia longifolia*.

During the years between 1927 and 1935 a team from the Geological Survey of Victoria visited the district around Yea and Alexandra to "secure additional data regarding the plant and graptolite association of the Silurian rocks of Victoria". Although providing further information for Lang and Cookson, details of the survey were not published until much later (Harris & Thomas, 1941). Mapping in the Walhalla district by Whitelaw (1916), Chapman (1924), and Baragwanath (1925) also contributed to palaeontological knowledge, especially the plant-graptolite association.

With this background, Lang and Cookson (1935) published their major contribution "On a flora, including vascular land plants, associated with *Monograptus* in rocks of Silurian age, from Victoria, Australia", in which the genus *Baragwanathia* was erected with species *longifolia*. The generic name was in honour of W. Baragwanath Jnr, Secretary for Mines, Director of the Geological Survey, and Chief Mining Surveyor, "in recognition of the collection of the first specimens from Thompson River". Baragwanath may have collected the first specimen from the Thompson River but not the first ever recorded, Nicholas' specimen from Avenel, which Lang and Cookson never sighted.

Baragwanath's main contribution was directing the supply of specimens and stratigraphic information collected by Geological Survey geologists over the years, as Cookson, a plant taxonomist, never ventured into the field.

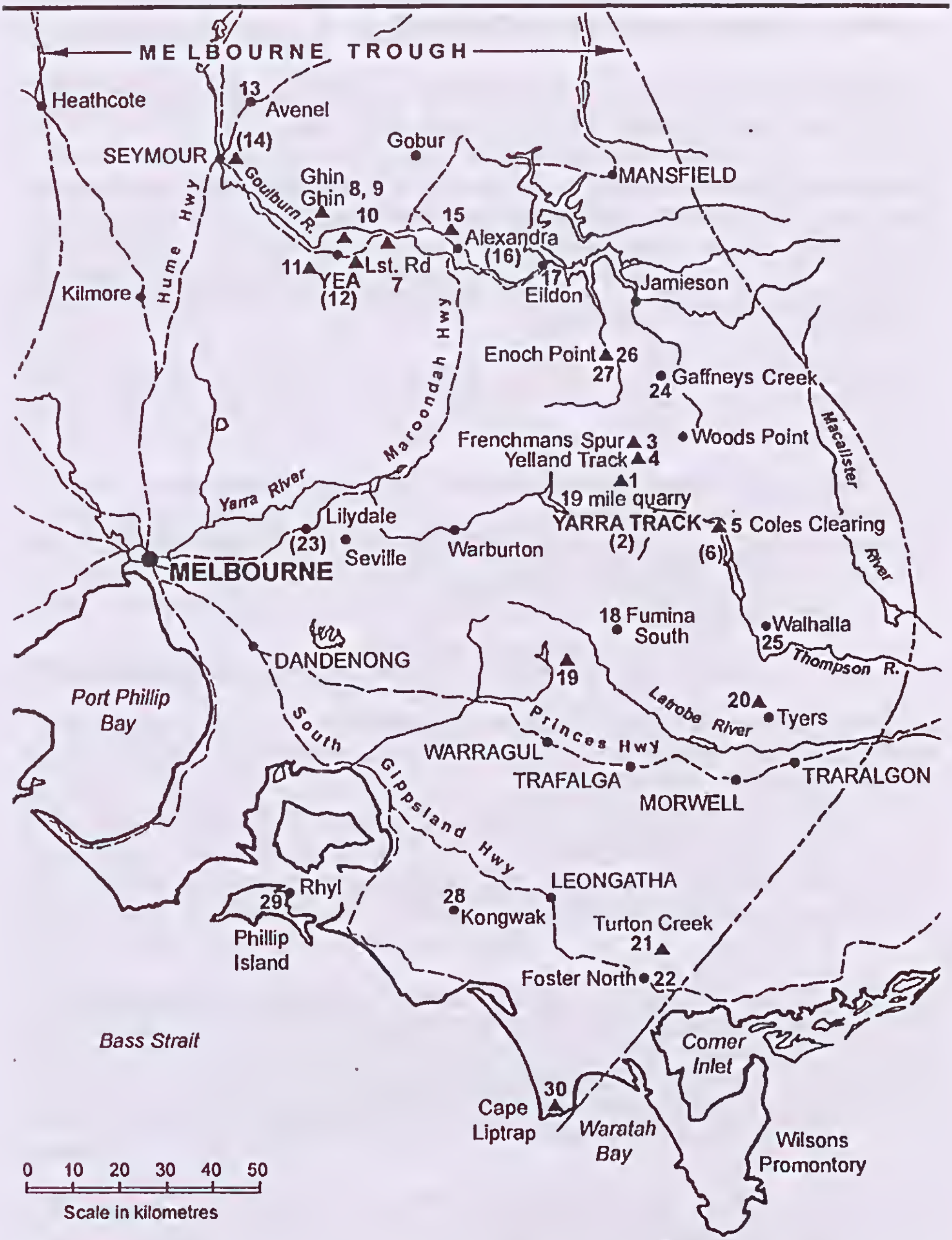


Figure 1. Distribution of *Baragwanathia longifolia* within the Melbourne Trough, Victoria. Numbered references to associated localities are shown in parenthesis. Refer Table 1. for detailed locality information.

Table 1. *Baragwanathia* flora localities.

This table is designed to provide the collector with more information on the localities shown in Figure 1. More precise information can be obtained by perusal of several of the papers in the REFERENCES at the end of this compilation.

Collection will also be facilitated by examination of the Geological Survey of Victoria, Melbourne, Warburton and Warragul 1:250 000 sheets. These indicate the extent of the Devonian Wilson Creek Shale and Norton Gully Sandstone, and the Humevale Formation from which Garratt (1978) distinguished the Silurian Yea Formation. Unfortunately more detailed modern geological maps of the 1:63 360, 1:50 000, and 1:25 000 series are rare in these areas.

Methodical examination of the hundreds if not thousands of exposures along the roads and tracks of the hill country in the 1:250 000 maps specified above would result in discovery of many new sites.

1	Yarra Track (Warburton-Woods Point Road), 19 mile quarry ("Type" locality)
2	Yarra Track (Warburton-Woods Point Road), associated localities
3	Frenchmans Spur Track (off Yarra Track)
4	Yelland Track (off Yarra Track)
5	Thompson River, Coles clearing
6	Thompson River, associated localities
7	Yea, Barclays Cutting Limestone Road (National Estate reservation)
8	Yea, Ghin Ghin Cutting, Ghin Ghin Road
9	Yea, Ghin Ghin Road near Goulburn River
10	Yea-Molesworth, Killingworth Road
11	Yea, Dairy Creek Road
12	Yea, associated localities
13	Avenel rail cutting near Seymour
14	Seymour-Avenel area
15	Alexandra, Eglinton Cutting, Maroondah Highway
16	Alexandra, associated localities
17	Eildon
18	Fumina South
19	Latrobe River (northeast of Warragul), Trafalgar 1:50,000 geol. map
20	Boola Boola State Forest (Track W2) near Tyers
21	Turtons Creek near Foster, South Gippsland
22	Foster North, South Gippsland Highway
23	Lilydale-Croydon, Hull Road (now inaccessible)
24	Gaffneys Creek (between Jamieson and Woods Point)
25	Walhalla
26	Enochs Point, Cables Creek
27	Enochs Point, Enochs Creek
28	Kongwak, South Gippsland
29	Rhyll, Philip Island (Bore 1)
30	Cape Liptrap, Livingstone Creek
31	New South Wales: Mudgee, Mount Wright

BARAGWANATHIA, A SILURIAN PLANT, 1935-1965

In describing *Baragwanathia* and *Yarravia,* Lang and Cookson used material from four areas; the Yarra Track, Alexandra, Killingworth Road, (see below) and the Thompson River. Graptolites associated with the plants from the first two localities were submitted to Dr. G. L. Elles (see Lang & Cookson, 1935) who placed their age "beyond doubt" as Early Ludlow (Late Silurian). Although graptolite experts Keble and Thomas of the Geological Survey were uneasy about the *Monograptus uncinatus* identification, the Early Ludlow age was accepted. At the time it would have been extremely difficult to contest this, as graptolites were then unknown from rocks younger than the Silurian. *Baragwanathia* therefore had to be considered the oldest vascular plant in the world, since the earliest vascular plants then known, from the northern hemisphere, were regarded as Early Devonian.

It should be noted however, that in two later papers, Cookson listed members of what had come to be known as the *Baragwanathia* Flora from formations of Early Devonian age. These were the Centennial Beds at Walhalla (1945), and "Yeringian" (Lower Devonian) beds from Lilydale (1949). The plants in the latter include *Zosterophyllum, Yarravia* and *Hedeia,* but not *Baragwanathia.*

AN EARLY DEVONIAN PLANT, 1966-1977

The stratigraphy of the Melbourne Trough had been undergoing continual review, but ultimately, the research to have most impact on the dating of the *Baragwanathia* Flora was probably the publication in the late 1950's of new information on graptolite species from the Lower Devonian of Bohemia. This and subsequent work on graptolites in Europe resulted in a reappraisal of *Monograptus* species associated with the plants, particularly those from the Norton Gully Sandstone and Wilson Creek Shale which had provided the greater number of *Baragwanathia* specimens.

Jaeger (1966) was guided by this in his paper "Two late *Monograptus* species from Victoria". He recorded *M. aequabilis,* a key fossil from the Lower Devonian of Bohemia, from the 20 mile quarry on the Yarra Track, and described a new species, *M. thomasi* from the nearby 19 mile quarry, the latter now regarded as the type locality for *B. longifolia,* although Lang & Cookson did not nominate a holotype.

M. thomasi is the species referred to by Elles as *Monograptus uncinatus* var. *orbatus,* the basis for the initial Silurian age determination for *Baragwanathia.* Subsequently Jaeger noted that *M. thomasi thomasi* extended throughout the Wilson Creek Shale whilst *M. aequalibilis notoaequabilis* occurred only in the upper half of the formation and in the Norton Gully Sandstone.

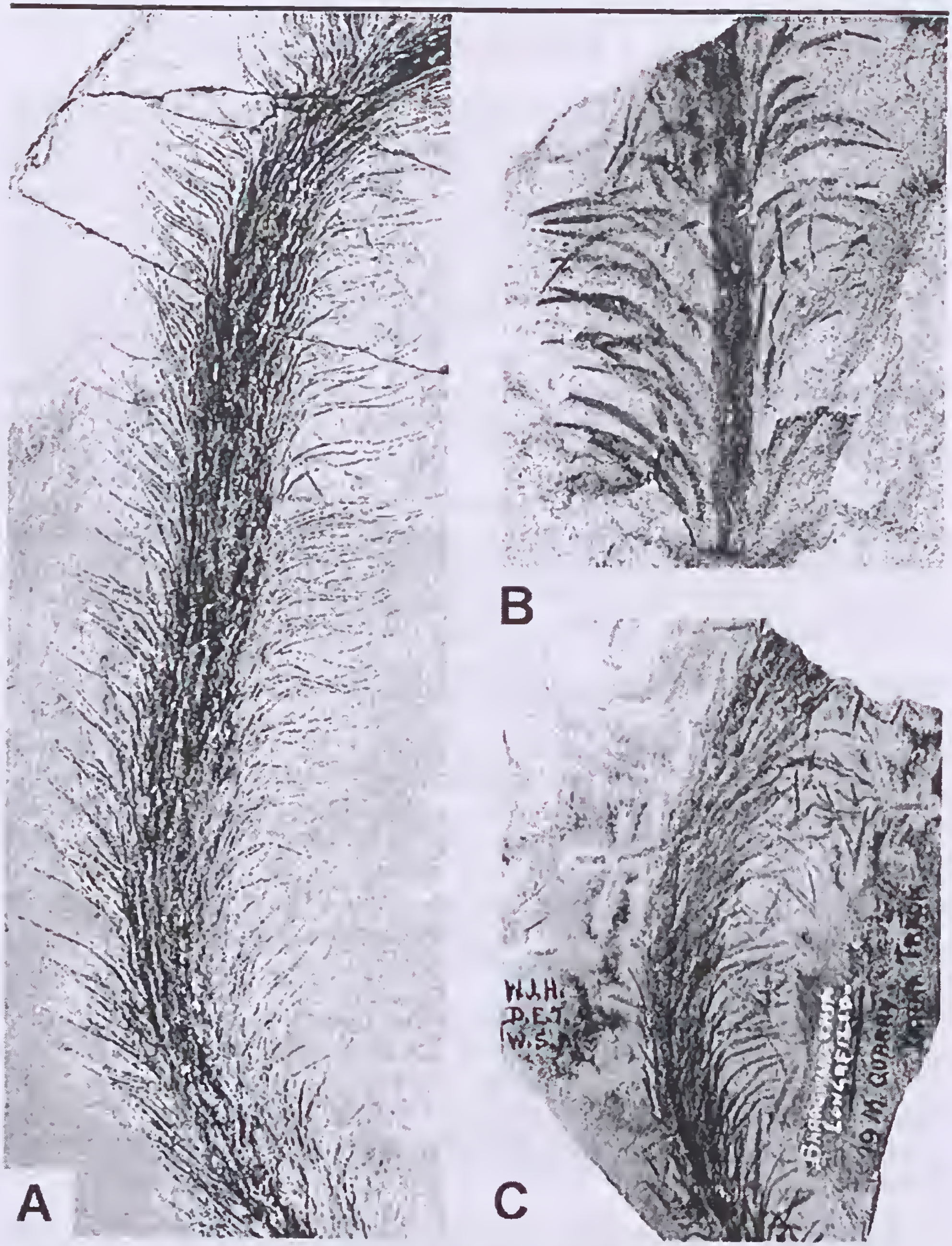


Figure 2. *Baragwanathia longifolia* Lang and Cookson, 1935. **A**, specimen NMV P157325 from Limestone Road, Yea, x 0.7; **B**, specimen NMV P33234 from Wilson Creek Shale, x 1.0; **C**, specimen NMV P202104 with *Monograptus* sp. from 19 mile quarry, Upper Yarra Track, x 0.65. Specimens held in Museum Victoria collection.

Papers by Harris & Thomas (1941), and Talent & Banks (1967), had reinforced the idea that all the plant graptolite beds were at the same stratigraphic level, the majority occurring in the Wilson Creek Shale. **This assumption placed the *Baragwanathia* Flora in the Early Devonian (Pragian),** rather than the Late Silurian (Ludlow), which gave great relief to northern hemisphere palaeobotanists who could not accept a plant (*Baragwanathia*), with comparatively advanced anatomical features preceding the occurrence of primitive Rhyniophytes in Europe.

A LATE SILURIAN PLANT, 1978

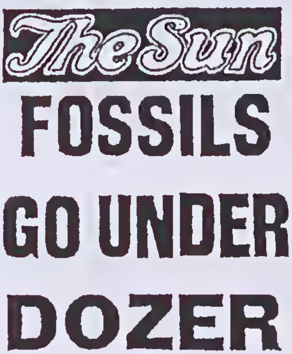
FROM THE OLDEST BEDS CONTAINING *BARAGWANATHIA*

Couper (1965), in his paper on the stratigraphy of the Yea-Molesworth district, reported the occurrence of two distinct plant-graptolite beds; an upper, located immediately below a conglomerate in the Flowerdale Sandstone Member (Williams,1964), and a lower, also below coarse clastics, named the Rice's Hill Sandstone Member (Garratt, 1977).

Couper and Garratt differed in their assessment of the stratigraphic separation of the upper and lower plant-graptolite beds. Either way it was obvious that a considerable time had elapsed between deposition of the upper and lower beds.

The controversy over the age of *Baragwanathia* was then renewed with much vigour when Garratt (1978) recorded graptolite species indicating **a Late Silurian (Ludlow) age for the lower plant-graptolite beds.**

Two major outcrops of the beds containing the lower plant-graptolite assemblage were found, one adjacent to the original 'Barclays Cutting' on Limestone Road, and the other in cuttings at Ghin Ghin. The former, because of better preservation of fossils and a much wider species range, has contributed most to the subsequent descriptive work. Fortunately extensive *in situ* collections were made from the Barclays Cutting during 1977 and 1978, because in 1979 the site was bulldozed by the Yea Shire Council.


The Sun
FOSSILS
GO UNDER
DOZER

A program of scientific collection along strike, with careful notation of relationships of plant and faunal fossils at one of the great fossil plant localities of the world was shattered in a single morning!

The entire centrefold (and a report in the news section) of the Melbourne "Sun" of July 28th 1979 was devoted to illustrations and discussion about the destruction of this site. However, the huge pile of resultant rubble has yielded many fine specimens of *Baragwanathia* and other fossils (see Figure 3. and

Table 2.), but access to further *in situ* material necessitates bulldozing of subsurface material, a task of some difficulty with the close proximity of the road surface.

Subsequently Garratt & Rickards (1984), re-identified the key graptolite species at Barclays Cutting as *Bohemograptus bohemicus bohemicus*, rendering the beds as "undoubtedly of Ludlow age". The identification of *Monograptus* cf. *uncinatus uncinatus* led them to conclude that "all the evidence suggests that the Ghin Ghin locality.... is also of Ludlow age".

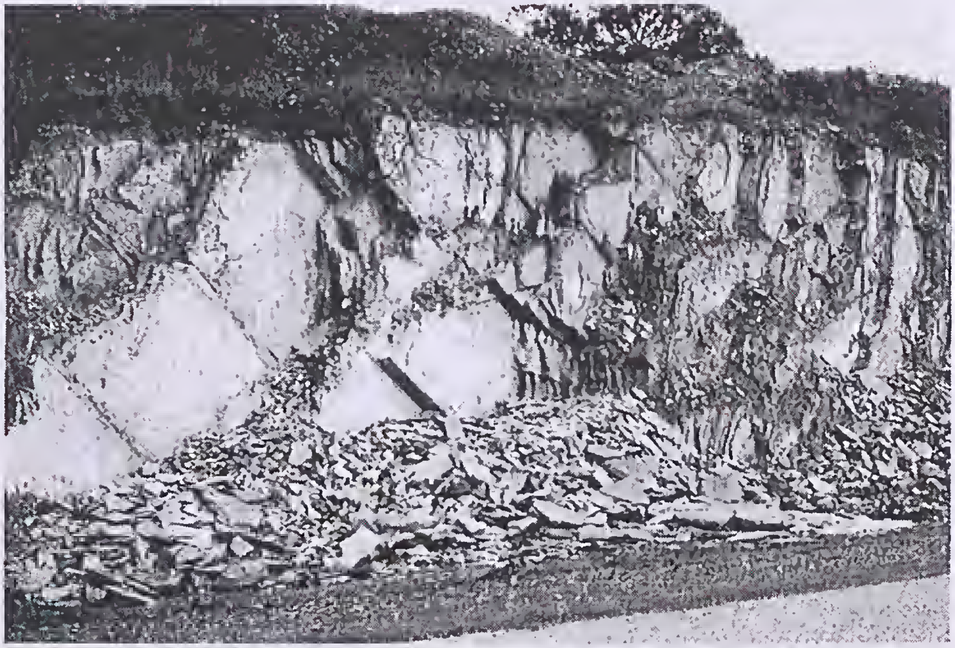


Figure 3. Barclays Cutting, Limestone Road, Yea. June 1977 (before bulldozing).

Garratt's 1978 reassertion of **a Late Silurian age for *Baragwanathia*** from the lower plant-graptolite beds elicited an immediate response from some overseas palaeobotanists, notably Edwards, D. et al. (1979), who considered that there were anomalies in Garratt's evidence; notably that "graptolites and plants at the lower horizon do not occur in intimate association, and are not found at the same bedding planes", and that shelly fossils indicated an Early Devonian age.

Garratt (1981), replied with refinement of the evidence for a Late Silurian age, but still failed to convince Hueber (1983) in his paper describing a new species of *Baragwanathia* from the Devonian of Canada.

Further collection from Ghin Ghin by Garratt, in conjunction with Rickards (1987, 1990), resulted in the identification of *Monograptus* cf. *prognatus* and *M.* cf. *pridoliensis.* This suggested a Pridoli or uppermost Silurian age, stratigraphically above the *M.* cf. *uncinatus uncinatus* beds of Ludlow age.

Cleal & Thomas (1999), failed to acknowledge the Ludlow dating of *B. bohemicus bohemicus,* stating that "a Pragian age for both assemblages seems more realistic", being concerned that Ludlow *Baragwanthia* was predated by the very much simpler vascular land plant *Cooksonia* by a mere three million years. *Cooksonia* named after Isabel Cookson, co-author of *Baragwanathia*, was originally recorded from the Late Silurian of England, but is now known from other sites including New York. From time to time other Silurian fossils that may or may not be vascular land plants, for example *Pinnatiramosus* (Geng, 1996), have been described, but again none of these reach the size of *Baragwanathia*.

Rickards (2000) responded by drawing attention to the all-important presence of *Bohemograptus,* suggesting that "At a time of rapid expansion of the vascular land plants, possibly in more than one province, three million years is.... more than long enough to evolve relatively more complex species"

Earlier Edwards, J. et al. (1997) had also noted, with no reference to graptolite faunas, that the "Yea and Humevale Formations .... are now considered part of the lithologically variable Norton Gully Sandstone", in a context which would date the lower plant-graptolite assemblage as Early Devonian.

However even more recently, but again without reference to key graptolites, VandenBerg (2003) stated that "Well preserved vascular plant fossils occur in various levels in the Upper Silurian and Lower Devonian rocks..."

And so the controversy continues with one contribution after another, but it is essential to remember that **current (and past) views of the age of the *Baragwanathia* Flora from any of a multitude of sites is principally based on the associated graptolite species.**

THE DIVERSITY OF THE *BARAGWANATHIA* FLORA

Considering the world-wide interest in the *Baragwanathia* Flora, it is disappointing that published description remains much as it did after the work of Cookson and Lang seventy years ago.

They described "leafy shoots", the longest of which was 28 cm., with stems (although often obscured) 1-2 cm in width, bearing narrow leaves up to 4 cm in length and 0.5 - 1 mm in width. They noted sporangia, often at the leaf base and concentrated in certain areas, possible rhizomes, as well as providing details of the woody structure.

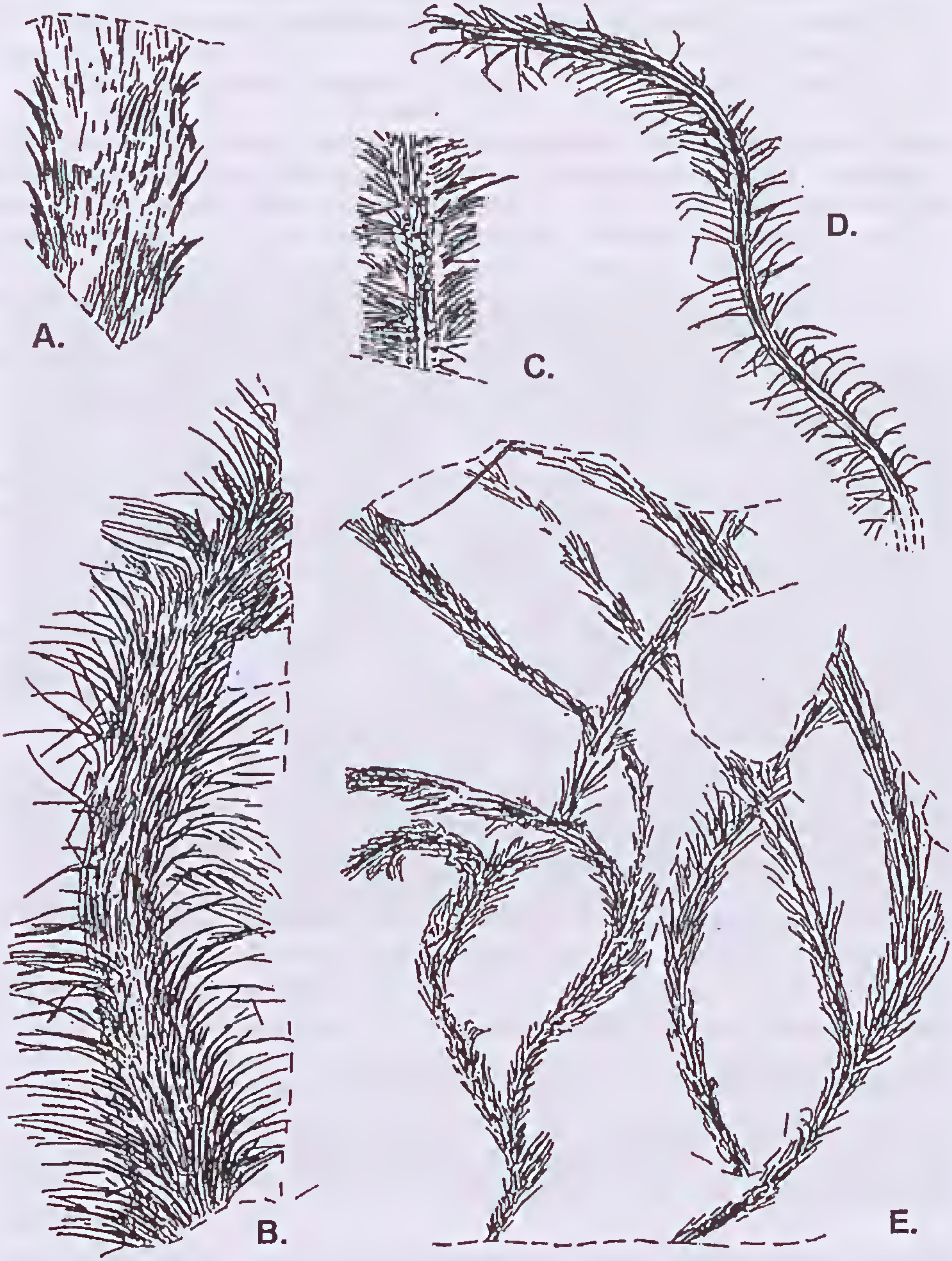


Figure 4. *Baragwanathia longifolia* stem segments x 0.45. **A**, Dairy Creek Road, Yea; **B**, 19 mile quarry, Yarra Track: **C-E**, Barclays Cutting, Yea.

Although there has been some more recently published work, very little of this advances our knowledge of *B. longifolia*, the plant that excites the interest of palaeontologists world-wide.

The principal contribution has been from Tims & Chambers (1984) who described *Salopella australis* from both the lower and upper plant assemblages, and *Salopella caespitosa* and *Dawsonites subarcuatus* from the upper plant assemblage. Gill (1965) also described a segment of *Baragwanathia* stem longer than any previously recorded (58.5cm).

Several papers on the algal component of the flora have been published. Douglas (1981) illustrated several Late Silurian and Early Devonian fossils attributed to the algae. (see also Table 2). Later (1983a) he described *Yeaia flexuosa* from the lower plant assemblage, a specimen representing an almost complete plant, a rarity in palaeobotany. In 1985, Douglas & Jell described two additional algae, one of which, *Buthotrephis walhalla,* was from the Norton Gully Sandstone. Shute & Edwards (1989) re-identified Cf. *Sporognites* of Cookson (1949) as the rhyniophyte *Uskiella.*

At the time of compilation of the original version of this story the Grampians Group was regarded as Upper Devonian–Lower Carboniferous in age. Reassessment by Cayley & Taylor (1997) and Young & Turner (2000) within the Silurian, brings the Sphenopsida? fossils from the Chimney Pot Gap locality (Douglas, 1965) under consideration as members of the *Baragwanathia* Flora, although no *B. longifolia* has been found in the Grampians.

There has also been interest in the fossil **fauna associated** with *Baragwanathia.* Burrow et al. (2002), described *Acutiramus* sp. cf. *Acutiramus bohemicus,* a eurypterid, from the Early Devonian Wilson Creek Shale at Turtons Creek. Burrow & Young (1999) described a teleostome fish, *Yealepis douglasi,* from the principal fossiliferous bed of the lower plant-graptolite assemblage at 'Barclays Cutting'.

Insufficient is known about the time range of either species to materially affect the controversy about the age of *Baragwanathia.* The same applies to the numerous shelly fossils, for example undescribed gastropods, the pteropod *Hyolithes,* the bivalve *Necklania,* the brachiopod *Maoristrophia,* and most plentiful of all, the orthocerids, found in association with *Baragwanathia* at 'Barclays Cutting'.

It should be noted that the first sentence in this section mentioned the lack of **published** descriptions. Tims (Ph.D. thesis, University of Melbourne, 1980) completed an extensive study of the early land flora of Victoria, naming and describing a new Baragwanathia-like plant, a new species of Bargwanathia, and describing several other possibly new lycophytes.

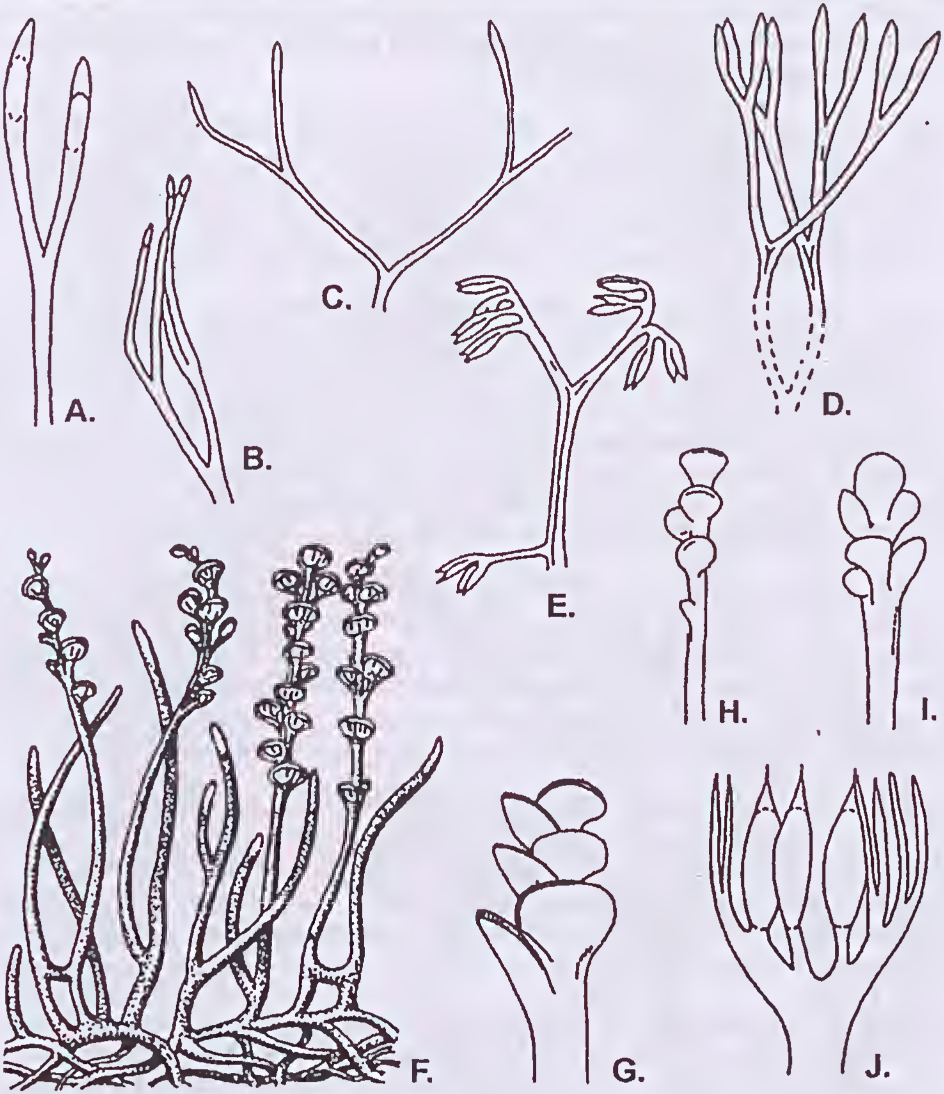


Figure 5. **A**, *Salopella australis* (holotype) x 1.6, , Frenchmans Spur; **B**, *S. caespitose* x 0.7, branches with sporangia, Frenchmans Spur; **C**, *S. australis* x 0.7, large branched specimen, Barclays Cutting; **D**, *S. australis* x 0.8, branches with spongia, Barckays Cutting; **E**, *Dawsonites subarcuatus* (holotype) x 2, Frenchmans Spur; **F**, reconstruction of *Zosterophyllum*; **G-I**, fertile spikes of *Zosterophyllum australis* x 2 (G & H, Centinnial Mine, Wallahala and I, Alexandra); **J**, fruitification of *Heideia* sp.'A'. x 2.5, Yarra Track. A-E from Tims & Chambers, 1984; F from White, 1986; G-J from Tims 1980.

Distinction of new forms has largely been based on differences in leaf concentration, arrangement and size, with intensified collection providing much more information on the immature plant. Many more fertile specimens have been examined, and Tims (thesis) expanded on anatomical detail first provided by Lang & Cookson. Tims also considered a pronounced and regular jointing in *Baragwanathia*-like specimens (Douglas 1976) from 'Barclays Cutting' to be a post-depositional phenomenon.

Further anatomical information has been obtained from scanning electron microscope examination of better preserved specimens, notably compression fossils from Turtons Creek (see Figure 6).

Table 2. Components of the *Baragwanathia* Flora.
*Fossils described by Tims (1980, unpublished thesis)
#Fossils determined by J. Douglas (manuscript in preparation)
Upper plant-graptolite assemblage members unhighlited
Lower plant-graptolite assemblage members in **bold**
Localities listed below are mainly compiled from published records, for others see **Table 1.**
Certain records are not listed e.g., those determined as "cf." or "aff".

Thallophyta	
Buthotrephis trichotoma	Kinglake
B. walhalla	Walhalla
Pachytheca sp.	Yarra Track, Turtons Creek, Walhalla
Sporogonites chapmani	Walhalla
Yeaia flexuosus	Barclays Cutting Yea
Unamed algae sp. 1-3*	Barclays Cutting Yea
Unamed alga sp. 4#	Turtons Creek
Prototaxitaceae ?	Mount William
Phaeophyta?	Barclays Cutting Yea
Rhodophyta?	Barclays Cutting Yea, Turtons Creek
Unamed algae sp. 5-7#	Barclays Cutting Yea
Psilophyta	
Hostimella sp.	Yarra Track, Turtons Creek, Walhalla
Rhyniophyta	
Hedeia corymbosa	Alexandra, Lilydale, also Tasmania
H. sp. A*	Frenchmans Spur, Barclays Cutting Yea Yarra Track, Ghin Ghin
H. sp. B*	Coles Clearing, Frenchmans Spur, Yarra
Salopella australis	Barclays Cutting Yea, Frenchmans Spur
S. caespitosa	Frenchmans Spur
Uskiella cf. *spargans*	Lilydale
Yarravia oblonga	Alexandra, Coles Clearing, Frenchmans Spur, Lilydale, Yarra Track
Yarravia subsphaerica	Yarra Track (Note: there has been confusion between *Hedeia* and *Yarravia*)

Rhyniaceae*	Coles Clearing
<u>Zosterophyllophyta</u>	
Zosterophyllum australianum	Alexandra, Lilydale, Walhalla, Woods Point, Yarra Track, Turtons Creek
Z. sp. A*	Boola Boola Track W2
Z. sp. B	Frenchmans Spur
Zosterophyllaceae sp. A*#	Barclays Cutting Yea,
Turtons Creek	
Z. sp. B*	Frenchmans Spur
Z. sp. C*	Barclays Cutting Yea
Z. sp. D#	Barclays Cutting Yea
Z. sp. E#	Barclays Cutting Yea
<u>Trimerophyta</u>	
Dawsonites subarcuatus	Frenchmans Spur
<u>Sphenophytina</u>?	
Sphenopsida?	Chimney Pot Gap
<u>Lycophytina</u>	
Baragwanathia longifolia	See Table 1.
B. sp. A*	Boola Boola Track W2, Frenchmans Spur
B. sp. B*	Barclays Cutting Yea
B. sp. C*	Barclays Cutting Yea
B. sp. D#	Turtons Creek
Lycophyte sp A*	Barclays Cutting Yea
L. sp. B*	Barclays Cutting Yea

PALAEOECOLOGY

The early Palaeozoic assemblages discussed above are from localities in Central Victoria within the geological structure called the Melbourne Trough, where the basement rocks are deposits of marine origin ranging from the Cambrian to middle Devonian. This trough forms part of an even larger structure called the Tasman Fold Belt which extends along the eastern margin of Australia.

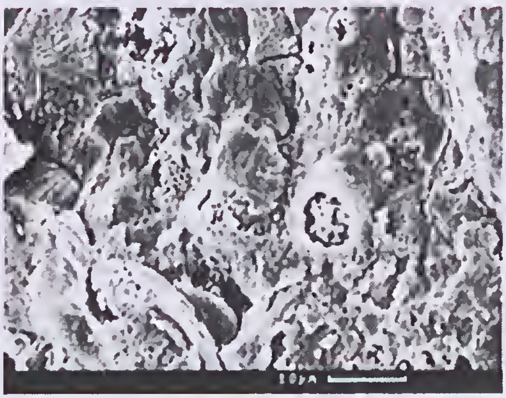


Figure 6. Stem tubercles of *Baragwanathia longiflora* from Turtons Creek (SEM photo by V. A. Krassilov).

Although *Baragwanathia* is fossilized in these marine beds, accompanied by marine fossils, it should be clearly understood that its woody structure shows that it was a land, and not a marine plant (Banks, 1972). Information from the sediments containing the fossils and examination of the fossils

themselves has been used to explore possible palaeoenvironments. For example, the Wilson Creek Shale is postulated as being deposited from a river system meandering through flats and coastal marshes periodically inundated by the sea. The Thallophytes would have been growing on near-shore reefs and washed into the mud flats. Some of the Zosterophylls may have been growing in the lower reaches and on slight elevations in deltaic swamps with the Rhyniophyte component, whilst the larger more woody forms of *Baragwanathia* grew in more elevated areas and were washed down and, during floods, deposited perhaps tens of kilometres from the shore in anaerobic mud and silt.

A reconstruction of an environment postulated for *Baragwanathia* fossilized in the Lower-Plant-Graptolite Assemblage at Limestone Road is shown below.

Figure 7. In the left foreground algal strands flow with the gently moving water, while on the silty and sandy bank to the right are the long strap-like branches of a zosterophyll. Across the channel (mid-left) ars the long slender stems and sporangia of the *Salopella* plant between the thick semi-submerged *Baragwanathia*. From Douglas 1983b.

SUMMARY

The lycophyte genus *Baragwanathia* and a large associated flora dominated the near-shore landscape of south eastern Australia for at least 20 million years.

Further research will greatly expand the number of components, and *B. longifolia*, although always the most common, will almost certainly be only one of several *Baragwanathia* species described.

Whatever the outcome of the age controversy, and whatever the world-wide search for other primitive plants reveals, the comment in the "Inspired observations" chapter of **Geology of Victoria (2003)** will remain indisputable.... "Because of its antiquity, its unheralded appearance as a well developed land plant, and its role as a pioneer coloniser of the land, *Baragwanathia*" is a landmark in Earth history".

Figure 8. A, Zosterophyllaceae sp.'A' x 0.4, Barclays Cutting, Yea; B, *Baragwanathia* sp. 'A' showing large leaf bases and scars; C, *Buthotrephis walhalla* x 0.4 (a thallophyte), Norton Gully Sandstone, Walhalla. A & B from Tims, 1980: C from Douglas 1985. Refer also Table 2.

REFERENCES

Banks, H. P., 1972. The stratigraphic occurrence of early land plants. *Palaeontology* 15: 365-377.

Baragwanath, W., 1925. The Aberfeldy District, Gippsland. *Mem.Geol. Surv.Vict.* 15

Birch, W. D. (Editor), 2003. Geology of Victoria. *Geol. Soc. Aust. Special Pub.* 23. Geol. Soc. Aust. (Victorian Division).

Burrow, C. J., Braddy, S. J., & Douglas J. G., 2002. Pterygotid eurypterid chelicera from the Lower Devonian of Victoria. **Alcheringa** 25: 263-268.

Burrow, C. J., & Young, G. C., 1999. An articulated teleostome fish from the Late Silurian (Ludlow) of Victoria, Australia. *Rec. West. Aust. Mus. Supp.* 57:1-14.

Cayley, R. A. & Taylor, D.H., 1997. Grampians. Special map area geological report. *Geol. Surv. Vict. Rept.* 107: 1-149.

Chapman, F., 1924. On the question of the Devonian age of the Tanjillian fauna and flora of Victoria. *Rept. Aust. Assoc. Adv. Sci.*, Adelaide (1926) 17: 313-318.

Cleal, C. J., & Thomas, B. A., 1999. *Plant fossils: the history of land vegetation.* The Boydell Press, Woodbridge, Suffolk, 188 pp.

Cookson, I. C., 1926. On the occurrence of the Devonian genus *Arthrostigma* in Victoria. *Proc. R. Soc. Vict.* 38: 65-69.

Cookson, I. C., 1935. On plant remains from the Silurian of Victoria, Australia, that extend and connect floras hitherto described. *Phil. Trans. R. Soc., London (Series B)*, 225: 127-148.

Cookson, I. C., 1945. Records of plant remains from the Upper Silurian and Early Devonian rocks of Victoria. *Proc. R. Soc. Vict.* 56(2): 119-122.

Cookson, I. C., 1949. Yeringian (Lower Devonian) plant remains from Lilydale, Victoria, with notes on a collection from a new locality in the Silurian-Devonian sequence. Mem. Nat. Mus. Vict. 16:117-131.

Couper, J., 1965. Late Silurian to Early Devonian stratigraphy of the Yea-Molesworth district, Victoria. *Proc. R. Soc. Vict.* 79: 1-9.

Douglas, J. G., 1965. Geology and structure of the Grampians area, Western Victoria. P. 92 *in* Spencer-Jones, D., Appendix 'B'. *Mem. Geol. Surv. Vict.* 25.

Douglas, J. G., 1974 Additions to the *Baragwanathia* flora. Unpub. Rept. 81: Geol. Surv. Vict.

Douglas, J. G., 1981. Fossil algae, Victoria, Australia. *The Palaeobotanist* 28-29: 8-14

Douglas, J. G., 1983a. A new Late Silurian thallophyte from central Victoria. *Proc. R. Soc. Vict.* 95: 275-277.

Douglas, J. G., 1983b. *What Fossil Plant is that? A guide to the ancient flora of Victoria.* Field Naturalists Club of Victoria, Melbourne.

Douglas, J.G. & Jell, P. A., 1985. Two thalloid (probably algal) species from the Early Devonian of central Victoria. *Proc. R. Soc. Vict.* 97: 157-162.

Edwards, D., Bassett, M. G. & Rogerson, E. C. W., 1979. The earliest vascular land. plants: continuing the search for proof. *Lenthia* 12: 313-324.

Edwards, J., Olshina, A. & Slater, K.R., 1997. Nagambie and part of Yea. *Geol. Surv. Vict. Rept.* 109.

Garratt, M. J., 1977. *Kinglake 1:63 360 geological map.* Mines Dept., Vict.

Garratt, M. J., 1978. New evidence for a Silurian (Ludlow) age for the earliest *Baragwanathia* flora. *Alcheringa* 2: 217-224.

Garratt, M. J., 1981. The earliest vascular land plant: comment on the age of the oldest *Baragwanathia* flora. *Lethaia* 14: 8.

Garratt, M. J., & Rickards R. B., 1984. Graptolite biostratigraphy of early land plants from Victoria, Australia. *Proc. Yorks. Geol. Soc.* 27: 377-384.

Garratt, M. J. & Rickards, R. B., 1987. Pridoli (Silurian) Graptolites in association with *Baragwanathia* (Lycophytina). *Bull. Geol. Soc. Denmark* 35: 135-139.

Garratt, M. J., Tims, J. D., Rickards, R. B., Chambers, T. C. & Douglas, J. G., 1984. The appearance of *Baragwanathia* (Lycophytina) in the Silurian. *Bot. Jour. Linn. Soc.* 89: 355-358.

Geng, B., 1996. *Acta Bot. Sin.* 28: 664-670

Gill, E. D., 1965. A unique specimen of *Baragwanathia longifolia* Lang and Cookson. *Wadia Comm. Vol. Min. & Met. Inst. Ind.* 348-351.

Harris, W. J. & Thomas, D. E., 1941. Notes on the Silurian rocks of the Yea district. *Min. geol. Jour. Vict.* 2(5): 302-304.

Hueber, F. M., 1983. A new species of *Baragwanathia* from the Sextant Formation (Emsian), Northern Ontario, Canada. *Bot. Jour. Linn. Soc.* 86: 57-79.

Jaeger, H., 1966. Two late *Monograptus* species from Victoria, Australia, and their significance for dating the *Baragwanathia* flora. *Proc. R. Soc. Vict.* 79:393-413.

Lang, W. H. & Cookson, I. C., 1927. On some Early Palaeozoic plants from Victoria, Australia. *Mem. Proc. Manche'r Lit. Phil. Soc.* 71: 45-51.

Lang, W. H. & Cookson, I. C., 1935. On a flora, including vascular land plants, associated with Monograptus, in rocks of Silurian age from Victoria, Australia. *Phil. Trans. R. Soc , London (Series B)*, 224: 421-449.

Nicholas, W., 1875. Report on the country between Tallarook and Longwood. *Rept. prog. Geol. Surv. Vict.* 2: 118-121.

Rickards, R. B., 2000. The age of the earliest club mosses: the Silurian *Baragwanathia* flora in Victoria, Australia. *Geol. Mag.* 137(2): 207-209.

Rickards, R. B. & Garratt, M. J. 1990. Pridoli graptolites from the Humevale Formation at Ghin Ghin and Cheviot, Victoria, Australia. *Proc. Yorks. Geol. Soc.* 48: 41-46.

Schute, C. H. & Edwards, D., 1989. A new rhyniopsid with novel sporangium organization from the Lower Devonian of South Wales. *Bot. Jour. Linn. Soc.* 100: 111-137.

Talent, J. A. & Banks, M. R., 1967. Devonian of Victoria and Tasmania. Pp. 147-163 *in* Oswald, D. H. ed. *International Symposium on the Devonian System 2.* Alberta Soc. Petrol Geol., Calgary:

Tims, J. D. 1980. *The early land flora of Victoria*. Ph.D. thesis, University of Melbourne (unpublished).

Tims, J. D. & Chambers, T. C., 1984. Rhyniophytina and Trimerophytia from the early land flora of Victoria, Australia. *Palaeontology* 27: 265-279.

VandenBerg, A. H. M., 2003. Silurian to Early Devonian. Pp. 117-155 *in* Birch, W. D. ed. *Geology of Victoria*. Geol. Soc. Aust. Special Pub. 23. Geol. Soc. Aust. (Victorian Division).

Vincent, A., V,. 1925. On the Silurian and Devonian floras, and the importance of their discovery in Victoria. *Rec. Geol. Surv. Vict.* 4: 501-507.

White, M. E., 1986. *The Greening of Gondwana*. Reed Books P/L, Sydney.

Whitelaw, O. A. L., 1916. The topography, geology, and mines of the Woods Point District. *Mem. Geol.Surv. Vict.* 13.

Williams, G. E., 1964. Geology of the Kinglake district, Central Victoria. *Proc. R. Soc. Vict.* 77: 273-327.

Young, G. C. & Turner, S., 2000. Devonian microvertebrates and marine-nonmarine correlation in East Gondwana: overview. *Cour. Forschun. Senckenberg* 223: 453-470.

Archaeopteris - The First Woody Tree

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Some fossils called 'missing links', combine characteristics that bridge the gap between the features of major animal or plant groups. The fossil plant *Archaeopteris* (not to be confused with the early bird *Archaeopteryx*) is one such missing link, as it combines features of both primitive spore-bearing ferns and advanced seed-bearing plants like conifers. It is the free-sporing plant most closely related to the seed-plants. *Archaeopteris* was perhaps the first true woody tree and one of the first plants to break away from swampy environments and invade a range of drier habitats, leading it to dominate many of the earliest forests. It developed structural innovations that were subsequently important in the evolution of seed plants. The rise of the first trees also dramatically influenced Late Devonian animal life, global climates, and erosion rates.

Archaeopteris (meaning "ancient fern") was first described in 1861 by Sir J. William Dawson, a Canadian geologist, who illustrated the plant's large fan-like leaves. Fifty years later, Russian palaeobotanist Mikhail Dmitrievich Zalessky discovered a new type of Devonian petrified wood, *Callixylon,* which bore resemblances to modern conifer wood. At the time, these fossils were considered unrelated despite the co-occurrence in beds throughout Europe and North America of both the leaves and wood. Another fifty years passed before American palaeobotanist, Charles Beck, made the startling discovery that *Archaeopteris* and *Callixylon* belonged to the same plant (Kenrick & Davis, 2004).

Beck's (1960) discovery led him to invoke the concept of the "progymnosperms", a group of plants that was intermediate between ferns and seed-plants; that is, a group having thick stems with secondary wood but fern-like reproduction (Beck, 1962; Benton & Harper, 1997). The progymnosperms now include a broad range of other plant groups from all continents and should not be considered a cohesive taxonomic group, but rather a loose association of plants with a similar "grade" of structural development. *Archaeopteris* is known from the Late Devonian (Frasnian), approximately 375 mya, until its extinction around the Devonian-Carboniferous boundary, although *Svalbardia* (which may represent a developmental stage of the *Archaeopteris* plant) occurs as early as the Middle Devonian (Berry & Fairon-Demaret, 2001). Until its decline after the Frasnian-Famennian biotic crisis, *Archaeopteris* played a dominant role in the earliest forests occupying alluvial habitats from polar to equatorial latitudes, although it appears to have become restricted to floodplains once its abundance began to decline (Kenrick & Davis, 2004).

Archaeopteris is the first plant in the fossil record to show conifer-like (or

pycnoxylic) wood; the trunks, surrounded by thick bark, consisting of lignified water-conducting tracheids and rays, new rings of wood being added each year (Meyer-Berthaud et al., 2000). These innovations allowed it to grow outwards as well as upwards. Trunks measuring 1.9 m in diameter have been found and reconstructions of *Archaeopteris* indicate it may have exceeded 30 m in height (Algeo & Scheckler, 1998: Fig. 1). Although the formation of a woody trunk is a costly process in terms of a plant's nutritional resources, it resists buckling and enables the tree to overtop its neighbours and branch profusely to develop a large crown.

Figure 1. Reconstruction of an *Archaeopteris* tree. Modified from http://biodidac.bio.uottawa.ca/

Archaeopteris was also the first tree to develop an extensive and penetrative woody root system. The deeper roots enabled broader access to soil resources, allowing them to colonise drier and more sparsely vegetated environments (Algeo.& Scheckler, 1998). The evolution of large root systems also led to increased weathering rates and thicker soils.

Archaeopteris evolved an additional competitive edge over its contemporaries by developing new patterns of lateral branching that allowed it to overcome stunting if damage occurred to the growing tip, thereby extending the plant's longevity. The branches grew almost horizontally and were arranged helically on the trunk. The leaves were quite variable – some being composed of small multi-veined fan-shaped leaflets whereas others were more irregular and branch-like (Fig. 2). In some species these leaves were orientated to prevent them from shading each other, thus increasing the photosynthetic potential of the tree (Kenrick & Davis, 2004).

Figure 2. Reconstruction of an *Archaeopteris* branch with variable leaf shapes. Microsporangia are indicated in black (modified from Phillips et al., 1972).

Figure 3. *Archaeopteris* sp. From the Devonian of Canada, length of specimen 40 cms. Photo courtesy of the University of Ottawa.

Archaeopteris reproduced by shedding free spores from sporangia borne on the upper surface of the fertile leaflets (Fig. 2). It produced two types of spores; microspores that were liberated to grow into the male gametophyte stage of the plant's life cycle, and megaspores that germinated to produce female gametophytes. The features of the gametophyte stage of these plants are not yet known, due to their unlikely preservation, although they were probably delicate and insignificant, much as they are in modern ferns.

Recently, abundant *Archaeopteris* wood has been discovered in the Moroccan desert where fossil trunks bear large branches that were reinforced at the base to withstand compressional and tensional load-bearing forces (Meyer-Berthaud et al., 1999). These features allowed the plants to adopt a wide variety of architecture, enabling them to better adapt to the circumstances of their immediate environment and to deal with stresses imposed by wind and storms.

The Frasnian saw the advent of the true forest canopy and *Archaeopteris,* particularly with its thick permanent branches and large crown, was capable of creating shade on a large scale. This may have disadvantaged some plant groups that depended on more open conditions, but it opened up new niches for shade-tolerant plants and animals (Algeo & Scheckler, 1998). With the rise of forests, the deep layer of leaf litter produced by the deciduous branches of *Archaeopteris* may have altered soil pH, moisture, and humic content that might have favoured survival of its own germlings (Algeo & Scheckler, 1998). It would also have provided a rich nutrient source for a range of new terrestrial invertebrates and fungi. Some have even argued that nutrients from more leaf litter entering watercourses contributed to the diversification of freshwater fishes (Scheckler, 1999) and the increased terrestrial biomass that possibly contributed to an increase in early wildfires (Perkins, 2001).

On a global basis, the development of forests in the Late Devonian led to greater oxygen production and carbon-dioxide drawdown. These atmospheric changes (O_2 increase from 5 to 20% and CO_2 decrease from 10 to 1%) probably influenced global climates and weathering processes, but to what extent they contributed to the biotic crises of the Late Devonian is not yet clear (Meyer-Berthaud et al., 2000; Algeo & Scheckler, 1998).

The Late Devonian plant fossil record in Australia has been poorly studied, so we do not firmly understand the composition of our earliest forests. Nevertheless, *Archaeopteris* was present on this continent as evidenced by leaf fragments from the Genoa River area of eastern Victoria (Douglas 1981: Fig. 4). Better Southern Hemisphere examples are known from the Witpoort Formation of South Africa (Fig. 5), where the leaves are preserved with algae and fish fossils.

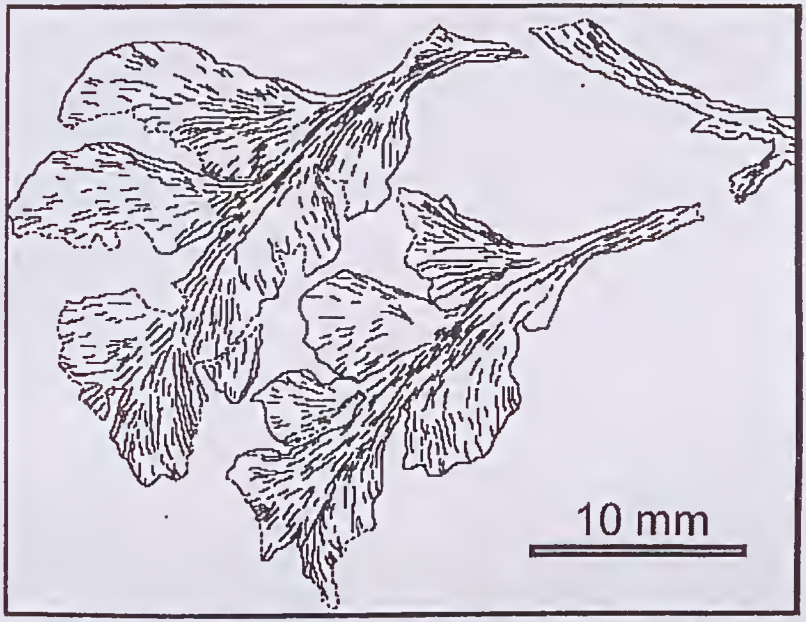

Figure 4. Line tracing of *Archaeopteris howitti* McCoy (Australian Museum Fossil 51185) from the Late Devonian, Genoa River, NSW-Victoria border.

Figure 5. *Archaeopteris* sp. from the Late Devonian Witpoort Formation, southwest of Grahamstown, South Africa (Courtesy of S. McLoughlin).

Archaeopteris is considered a cornerstone taxon – perhaps the first woody tree. The adaptations achieved by this Late Devonian plant were refined by its successors and its evolutionary legacy can be seen around us in the plants that dominate our modern forests.

REFERENCES

Algeo, T. & Scheckler, S., 1998. Terrestrial-marine teleconnections in the Devonian: links between the evolution of land plants, weathering processes, and marine anoxic events. *Phil. Trans. Roy. Soc. London B: Biol. Sci.* 353: 113-130.

Beck, C.B., 1960. The identity of *Archaeopteris* and *Callixylon*. *Brittonia* 12: 351-368.

Beck, C.B., 1962. Reconstruction of *Archaeopteris* and further consideration of its phylogenetic position. *Am. J. Bot.* 49: 373-382.

Berry, C. & Fairon-Demaret, M., 2001. The Middle Devonian Flora Revisited. Pp.120-139 *in* Gensel, P. & Edwards, D. (eds), *Plants invade the land: evolutionary and environmental perspective*. Columbia University Press: New York.

Benton, M. & Harper, D., 1997. *Basic Palaeontology*. Pearson Prentice Hall: Harlow.

Douglas, J.G., 1983. *What fossil plant is that.* Field Naturalists Club of Victoria: Melbourne.

Kenrick, P. & Davis, P., 2004. *Fossil Plants*. London: Natural History Museum.

Meyer-Berthaud, B., Bousquet J. & Scheckler, S., 2000. The development of *Archaeopteris:* New evolutionary characters from the structual analysis of an early Famennian trunk from southeast Morocco. *Am. J. Bot.* 87: 456-468.

Meyer-Berthaud, B., Scheckler S. & Wendt., J. 1999. *Archaeopteris* is the earliest known modern tree. *Nature* 398: 700-701.

Perking, S., 2001. They're not briquettes but they'll do. *Science News* 159: 309.

Phillips, T.L., Andrews, H.N. & Gensel, P.G., 1972. Two heterosporous species of *Archaeopteris* from the Upper Devonian of West Virginia. *Palaeontographica* 139B: 47-71.

Scheckler, S., 1999. Earlist modern tree lived 360-345 million years ago. http://www.vtnews.vt.edularchives/1999/99182.html

BOOKS AND BOOK REVIEWS cont

WHAT FOSSIL PLANT IS THAT?: A guide to the ancient floras of Victoria by Jack Douglas. Published by the Field Naturalists Club of Victoria, 1983. ISBN 0 9598074 6 2.

Back in January, 1984 (Bulletin 12), we briefly reviewed the above book with the comment "It is indeed refreshing to have a book on fossils that introduces the reader to some basics of sedimentary geology and an outline of geological history as it relates to the various formations in which fossil plants are found".

In view of the update of the *Baragwanathia* Story contained in this bulletin, it is worth noting that "What Fossil Plant is that?" is still available at a reduced price of AU$5.00. Should anyone be interested in obtaining a copy, the FCAA Secretary, Frank Holmes, will purchase copies from the Field Naturalists Club of Victoria and post them to subscribers at cost, i.e. $7.50 ($5.00 + large letter postage of $2.45 & envelope). Alternatively you can make your own arrangements with the FNCV at 1, Gardenia Street, Blackburn, VIC.3130. Telephone (03) 9877 9860, email: vicnat@vicnet.net.au